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Inventor: Robert M. BEST

Invention: Linked Game Systems With Stereoscopic Display

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Graybeal Jackson Haley LLP
Attorneys at Law
155 108th Avenue NE, Suite 350
Bellevue, WA 98004-5973
(425) 455-5575
Fax (425) 455-1046

SPECIFICATION

TITLE OF THE INVENTION

Linked Game Systems With Stereoscopic Display

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This is a continuation in part of application Ser. No. 09/928,294 filed August 10, 2001, which is a continuation in part of application Ser. No. 09/853,487 filed May 10, 2001, the entire contents of which are incorporated by reference herein.

FIELD OF THE INVENTION

[0002] This invention relates generally to electronic game systems and more particularly to portable game systems that provide 3-dimensional displays.

BACKGROUND OF THE INVENTION.

[0003] Handheld portable game systems that have liquid crystal display (LCD) screens, video game console systems, and handheld control units are well known and are described in my US patent 5,393,073. Patent application GB 2,353,928A discloses a game system having a console connected to multiple handheld game machines with LCD's that display maps including squares to indicate player-controlled characters, circles to indicate monsters, and diamonds to indicate items. Although this patent application maintains that these maps are pictures, the application does not provide any examples of pictures of animated characters with hands, arms, legs, faces, and clothing in simulated game worlds for display on portable game systems. Likewise, US patent 6,132,315 links portable game systems to a game console, but does not display any animated characters on LCD screens in response to data from the console system.

[0004] Therefore, a need exists for linked video game systems that display more natural visual information such as pictures on linked portable game LCDs, especially pictures of animated player characters and other objects that are rendered as 3-dimensional (3D) texture-mapped polygons, and also display multiple views of the game characters on the LCDs from different points of view and angles in a natural-looking game world.

[0005] It is also desirable for the 3D characters to be displayed stereoscopically in a 3D world on the LCD display device.

SUMMARY OF THE INVENTION

[0006] An embodiment of this invention is a video game system that includes two or more game systems, both of which can generate 3D moving characters as texture-mapped polygons. One or more of the linked systems is a portable game system contains an LCD screen that displays pictures of areas of a 3D world with 3D rendered polygon characters, and may also display maps, words, numbers, etc. The other game system may generate animated pictures for display on a television (TV) screen. During game play, a handheld controller may provide manual control of animated 3D player-controlled characters that are texture mapped polygons displayed on the LCD screen.

[0007] Simulated 3D characters such as people are displayed on the LCD screen of one or more portable game systems in a 3D pictorial game world. In the preferred embodiment, the 3D characters, other 3D objects, and the 3D game world are displayed autostereoscopically to stimulate depth perception in each player's vision without requiring polarizing eyeglasses or other head-mounted viewing aids.

[0008] Each game system generates a simulated 3D game world populated with animated 3D characters and static objects which are generated from multiple viewpoints in the 3D world. Images generated from pairs of these viewpoints can simulate images viewed from a player's two eyes. Because of parallax in a player's binocular vision, each player viewing the game world from a pair of stereoscopicly separated points of view will experience depth perception of the simulated 3D game world.

[0009] The game system in general will provide a unified game experience in which a combination of display units provide more visibility of the game world from multiple viewpoints and a more vivid game world when viewed stereoscopicly. Some of the pictures displayed on the LCD screens may represent different areas of the simulated world at different times, or the same area at the same time.

[0010] By displaying pictures of people and animals stereoscopicly as pairs of 3D views of the characters moving in the 3D game world and from variable viewpoints, the characters may be presented to players with vivid realism, unlike flat characters represented as symbols. Polygon-rendered 3D pictures of game characters in 3D worlds will provide quicker and more accurate recognition and selection of locations, directions, orientation, and actions of game characters. In addition, displaying the 3D characters in the 3D world stereoscopicly will make the game experience much more vivid and enjoyable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Fig. 1 illustrates a game player operating a portable game system that is linked to another portable game system that displays additional 3D game world images.

[0012] Fig. 1a illustrates a game player operating a controller and viewing 3D game world images on an LCD screen in a portable game system linked to a console game system.

[0013] Fig. 2 illustrates two game players operating two linked portable game systems that display 3D game worlds on LCD screens.

[0014] Fig. 3 is a block diagram of an exemplary video game console system linked to a portable game system that provides stereoscopic 3D images.

[0015] Fig. 4 illustrates images of a 3D object that are generated from two different viewpoints and virtual camera angles for display on a portable game system LCD.

[0016] Fig. 5 illustrates images of a 3D object that are generated from two different viewpoints and virtual camera angles for display on a portable game system LCD that provides stereoscopic 3D images.

[0017] Fig. 6 is a block diagram illustrating how images of a simulated 3D game world are generated from two viewpoints for stereoscopic display on an LCD.

[0018] Fig. 7 is a perspective view of a portable game system that displays 3D game worlds from two viewpoints for stereoscopic display on an LCD.

[0019] Fig. 7a is a 3-dimensional (x, y, z) cartesian graph illustrating 3D coordinates of virtual cameras and an object viewed from two different viewing angles in the 3D world.

[0020] Fig. 8 is an exemplary memory map of programs and data in a console RAM.

[0021] Fig. 9 is an exemplary record format of a data record for transmitting data between two game systems.

[0022] Fig. 10 is an exemplary memory map of various programs and data stored in a portable game system RAM.

[0023] Fig. 11 is a data map of game programs and data stored on an optical disk or other data carrier.

[0024] Fig. 12 illustrates two linked portable game systems that display 3D game worlds on autostereoscopic LCD screens with a 2D display option on each system.

[0025] Fig. 13 illustrates a cross-sectional view of an autostereoscopic LCD display device described in US patent application 2004/0012671.

[0026] Fig. 14 and 14a illustrate cross-sectional views of two alternative autostereoscopic LCD display devices described in US patent 6,055,013.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENT

[0027] Fig. 1 illustrates an exemplary game playing session in which human game player 10 manipulates control members on portable game system 44 while viewing pictures of portions of a simulated 3-dimensional game world and other visual images displayed on LCD screen 22 on a second portable game system 47. Portable game systems 44 and 47 are digitally linked by cable 45, wireless, or other data transmission means. Wireless includes radio waves, infrared, ultrasound, optical fiber, and other data transmission methods.

[0028] As player 10 manipulates control members on portable game system 44, his player character (displayed on LCD screen 22 in portable game system 47) and/or other objects are rendered as 3D textured polygons moving in a simulated 3D world as viewed from different viewpoints and angles. The player character is not just a symbol representing a character, but rather is generated as images of a human-like or animal-like character with multiple body parts such as hands, arms, legs, faces, and clothing.

[0029] Both portable game systems 44 and 47 contain processors that generate the same or different simulated 3D game worlds in which 3D characters and other objects move in 3-dimensions. Both systems 44 and 47 generate pictures of characters and other objects that may be viewed from different viewpoints and angles in the simulated 3D worlds. Player 10 may operate control members on portable units 44 and 47 to select alternative views of the 3D simulated world for display on LCD 22 in either of portable game systems 44 and/or 47. Manipulation of control members in system 44 may cause digital data to be transmitted to portable game system 47 that may, for example, cause system 47 to generate views from a different viewpoint and/or angle for display on LCD screen 22.

[0030] Portable game systems 44 and 47 transmit digital data to each other to synchronize the two systems so that different views of the same spot in the same simulated 3D world will include the same objects performing the same actions at the same time.

[0031] By having two or more portable game systems 44 and 47 each with LCD display devices and executing the same game programs, each LCD may display different objects in the 3D simulated world that are viewed from different viewpoints and angles. A player may select and monitor trouble areas in the simulated world, similar to a security guard monitoring closed-circuit television pictures from security cameras. A program in one of the portable game systems may cycle through several views of the simulated world selected by player 10 for display in succession on one or more LCD screens.

[0032] A map of one part of the simulated world may be displayed on one LCD 22, while a picture of a portion of the simulated 3D world is displayed on a second LCD. Portable game system 47 is supported by a table 187, shelf, or other support.

[0033] One or both portable game systems 44 and/or 47 may contain LCD displays that are stereoscopic, preferably autostereoscopic (which require no eyeglasses or goggles), so that a player may experience full depth perception of 3D characters and other objects and the 3D world viewed from different viewpoints on at least one of the two game systems. Such stereoscopic LCD displays are described below with reference to Figures 13, 14, and 14a.

[0034] Fig. 1a illustrates an exemplary game playing session in which game player 10 manipulates control devices on handheld controller 185 while viewing pictures of portions of a simulated 3D game world and other visual images displayed on LCD screen 22 in portable game system 47. Controller 185 and portable game system 47 are digitally connected by cable 45, wireless, or other data transmission means to console 42 which normally generates a video signal to an optional video display unit or TV 11 for display. In this example, console 42 transmits data to and from controller 185 and portable game system 47. In addition, console 42 may also read game programs and data from a software distribution medium such as a disk and download the programs and data to portable game system 47, as described below with reference to Fig. 3.

[0035] Player 10 manipulates control members on controller 185 to select alternative views of the simulated 3D game world for display on LCD 22 in portable game system 47. Controller 185 transmits control data to console 42 which responds by transmitting control data 154 (Fig. 3) to portable game system 47 that generates picture data for display on LCD screen 22 in accordance with the control data from controller 185.

[0036] Fig. 2 illustrates an exemplary game playing session in which two game players 10 and 12 play a multiple-player game which is displayed on two portable game systems 44 and 47 respectively. Each portable game system is equipped with a miniature joystick 20 and a processor for generating textured polygons in 3-dimensions as described below with reference to Fig. 12. In the preferred embodiment, LCD 22 is stereoscopic, preferably autostereoscopic and displays images of different objects in a simulated 3D world that are viewed from different viewpoints and angles.

[0037] Portable game systems 44 and 47 communicate with each other through data transmission link 45 which may be wireless or may use wires. Systems 44 and 47 transmit digital data to each other through link 45 to synchronize the two systems so that different views of the same spot in the same simulated 3D world will include the same objects performing the same actions at the same time. Exchanged data on link 45 also insures that any changes made to the 3D game world generated by one system as a result of player control will also be made to the 3D game world generated by the other system and vice versa.

[0038] Fig. 3 is a simplified block diagram of the major components of an exemplary video game system indicated generally at 19. Video game console 42 includes a housing indicated by the dashed line in Fig. 3 and shown in isometric view in Fig. 1a. Disk 43 is shown outside this housing for clarity, but may be played within the housing. Inside this housing is a small computer comprising microprocessor 86, RAM 90 for storing game programs and data, boot ROM 91 (not shown) for power up and reset, and may include an operating system such as DOS, non-volatile EPROM 89, EEPROM, or battery-powered SRAM for storing digital information that is different for each game console 42, video signal generator 117 for generating composite, separate audio and video, or digital signals suitable for input to TV 11 or a video monitor (not shown), and peripheral interface chip 88 (not shown) for sending and receiving digital data to and from portable game systems 42 and 47.

[0039] For clarity, specialized coprocessors for D/A conversion, audio, or for rendering texture-mapped polygons in 3D, terrain rendering, and related graphics processing are not shown. However, the polygon-rendering functions are indicated by processes 301 and 301a.

[0040] Disk reader 83 reads digital information from tracks of microscopic pits that are molded into each disk by a disk manufacturer. Digital information in these tracks includes video game programs and data. Much of the digital information read from disk 43 by disk reader 83 is controlled by security processor chip 84 so that chip 84 can prevent processing of video game data from unauthorized disks.

[0041] When disk reader 83 reads game programs into RAM 90, the programs in this example are of two kinds, console program(s) 151 with associated data, and portable game system program(s) 152 with associated data. Portable program 152 is transmitted to RAM 53 in portable game system 47 and executed in microprocessor 50. Console program 151 is stored in RAM 90 and executed by microprocessor 86 which generates animated picture data 146a representing textured polygons for one or more 3D animated characters performing actions in the simulated 3D game world. This picture data stored in RAM 146a is converted to a video signal on cable 41 or wireless equivalent. Optionally, this video signal is transmitted on cable 41 to TV 11 and is displayed as animated pictures on TV screen 56. TV display is not required in the examples illustrated in the other figures herein.

[0042] In portable game system 47 picture data representing moving 3D objects in variable 3D views of the simulated 3D game world(s) are rendered as 3D textured polygons in process 301 so that 3D characters and other objects in animated picture data 146 can be viewed from variable and rapidly changing 3D points of view and angles selected by players.

[0043] Processor 50 also executes instructions stored in boot ROM 76 and may also execute instructions stored in non-volatile external memory 16. Memory security processor 52 prevents execution of unauthorized instructions read from external memory 16.

[0044] Microprocessor 86 also generates data records which it sends (arrow 154) to portable game system 47. An example of a data record 78 is discussed below with reference to Fig. 9. Other record formats may be used by programs 151 and 152.

[0045] Execution of console program 151 is controlled by manual controller 185 (Fig. 1a) and by data received (arrow 153) by console 42 from microprocessor 50 in portable unit 47. Microprocessor 50 receives (arrow 154) the data records sent from console 42 and this data affects execution of program 152 in microprocessor 50 which also receives manually entered input signals from direction-switch 15 (only one of the 4 switches is shown), analog joystick 20, and/or other manual controls. These input signals result from a human player's decisions based on animated pictures that are displayed on LCD 22 from animated picture data 146 generated by microprocessor 50 executing program 152 in RAM 53 and rendered in process 301 as textured polygons. The input signals also control execution by microprocessor 50 which sends data records (arrow 153) to console 42.

[0046] In the preferred embodiment, LCD 22 displays autostereoscopic images (which require no eyeglasses or goggles), so that a player may experience full depth perception of 3D characters and other objects and the 3D world viewed from different viewpoints on portable game system 47. In the autostereoscopic LCD device described below with reference to Fig. 13, the stereoscopic feature may be electrically disabled so that LCD 22 may display 2D images such as maps, words, statistics, etc. Microprocessor 50 generates a signal (marked 3D in Fig. 3) which enables or disables parallax barrier 337 illustrated in Fig. 13. If the 3D signal is not enabled, parallax barrier 337 is transparent for 2D images.

[0047] Fig. 4 illustrates how a 3D object 17 (a player character in this example) can be displayed on LCD screen 22 from different angles, depending on the 3D point of view (perspective) from which a simulated virtual "camera" is calculated within a 3D game world generated by processor 50 in portable game system 47. In this example, processor 50 generates three different images of object 17 from three different viewpoints indicated by the three simulated "cameras" 173, 175, and 215. The non-stereoscopic image of character 17 being displayed on LCD 22 is calculated from viewpoint 175 as indicated by the line of dots in Fig. 4.

[0048] The word "camera" is used herein in the sense used in US Patent 6,139,433, columns 33-34. "Camera" is a metaphor for a point of view (viewpoint, POV, or perspective) in a simulated 3-dimensional game world from which picture data for a portion of that world is computed.

[0049] Character 17 is 3-dimensional in the sense that the displayed points of body and clothing texture form a three-dimensional surface in the simulated 3D game world, not a planar surface. However, the picture displayed on LCD 22 is a projected 2D image and all the pixels in the image are calculated from one viewpoint 175 in this example.

[0050] The picture of object 17 generated from the viewpoint of virtual camera 175, i.e. the picture displayed on LCD 22, may be recalculated from many other viewpoints and camera angles such as 177 and 216. These recalculated images are projected at variable camera angles (a direction that may be controlled by a human player) onto a virtual 2D plane orthogonal to the line intersecting object 17 and virtual camera 175.

[0051] Such projected images of object 17 are consistent with the 3-dimensional shape of character 17, even though the projected images are 2-dimensional.

[0052] The player may relocate a virtual viewpoint by pressing a combination of buttons or other manipulatable devices on handheld controller 185 (Fig. 1a) or LCD portable game unit 47 or by pointing to object 17 with a cursor or highlight on LCD 22 using a manipulatable device or a combination thereof in a handheld controller. A player may also select a viewpoint by moving a cursor on a map displayed on LCD screen 22 by manipulating control devices in portable game system 44 or 47. A player may also retain the same viewpoint while manually changing angle 177 to direct camera 175 at another object.

[0053] When a player selects a viewpoint 175 and a direction angle of view 177 and a picture of object 17 from that perspective is generated for display on LCD 22, the player may zoom-in on object 17 by manipulating a control member on a handheld controller 185 or game system 47. This enables a player to observe a close-up picture of, for example, a character's hand performing a manual task in greater detail on LCD 22. The player may also zoom-out by manipulating a control member which causes the picture on LCD 22 to cover a broader field of view.

[0054] Fig. 5 illustrates how a 3D object 17 (a player character in this example) can be displayed on LCD screen 22 as a stereoscopic image using the same image generation processes described above with reference to Fig. 4. The two viewpoints or virtual "cameras" 175 and 215 that view object 17 from different angles, may be used as two virtual "eyes" by changing the way the generated pictures are displayed on LCD 22.

[0055] As illustrated in Fig. 4, two pictures of object 17 in Fig. 5 are generated as textured polygons from two different viewpoints 175 and 215 for display on LCD 22 (indicated by the two lines of dots). By using a stereoscopic LCD 22 in portable game system 47 such as described below with reference to Fig. 13, 14, or 14a, and by sending generated picture data representing viewpoints 175 and 215 to alternating columns of pixels in the LCD display plane (Fig 13), a stereoscopic effect is produced as if viewed by a pair of virtual cameras presenting a pair of stereoscopic images to a player's left eye and right eye.

[0056] As illustrated in Fig. 4, and likewise in Fig. 5, the directions from which object 17 is viewed are variable and may be manually controlled by the player. When the pair of images are zoomed-in for a close-up, angles 177 and 216 are increased to provide an illusion that object 17 is closer to cameras 175 and 215. Cameras 175/215 may also zoom out and angles 177 and 216 reduced so that object 17 appears more distant on LCD 22.

[0057] A human player controls movements, directions, zoom, and point-of-view perspectives of cameras 175 or 215 using a directional input control member, such as direction-switch 15 or joystick 20 in handheld controller 185 (Fig. 1a) or in portable game system 47 (Fig. 2) or similar control members.

[0058] Object 17 may be viewed from any angle horizontally and in three dimensions from above and from below (not shown), where the viewing direction is centered on or near object 17 or any other object selected by the player. The viewpoint pair 175 / 215 may circle around object 17 and be directed toward object 17, so that LCD 22 displays object 17 from many different viewpoints and directions and camera angles in the simulated 3D game world stereoscopicly.

[0059] Fig. 6 illustrates processes for generating 3D objects in a 3D game world for display on stereoscopic LCD 22 in portable game system 47. Stored in RAM 53 is data that represents a 3D game world, data defining 3D characters and objects populating the game world, and program instructions for generating picture data. Additional data 78 is received from the other system (portable game system 44 or video game console system 42) that specifies variables regarding objects, locations, viewing angles, etc. Processor 50 executes program instructions from RAM 53 to generate graphics commands for a graphics co-processor 301 (not shown) to perform process 68 that generates picture data rendered as texture mapped polygons representing a moving 3D object 17 against 3D background terrain as viewed from viewpoint 175.

[0060] Likewise process 69 generates picture data representing object 17 and background as viewed from viewpoint 215. This rendered picture data is stored in display RAM 302 in alternating columns of pixels; even numbered columns 74 for viewpoint 175 (left eye) and odd numbered columns 75 for viewpoint 215 (right eye). The resulting array of interlaced pixel data 338 is stored in display RAM 302. LCD drivers 119 feed each pixel data element from display RAM 302 into the corresponding row and column of dot matrix LCD 22. An LCD driver 119 also enables parallax barrier 337 for 3D mode.

[0061] Fig. 7 is a perspective view of an exemplary portable game system 47 that includes miniature analog joysticks 20 and 21 for manually controlling fine movements of player characters and virtual cameras in simulated 3-dimensions. LCD 22 is preferably an autostereoscopic display device (that requires no eyeware) as described below with reference to Figures 13, 14, and 14a. Cross-shaped switch 15 may be a conventional

direction switch. External memory 16 may contain non-volatile semiconductor memory or optically coded disk. Audio is provided by speaker 27

[0062] Fig. 7a is a 3-dimensional graph illustrating cartesian coordinates ($X_1 Y_1 Z_1$) of an exemplary viewpoint of virtual camera 175 and coordinates ($X_2 Y_2 Z_2$) of an exemplary object 17 being viewed from 3D viewpoints 175 and 215 as described above with reference to Figs. 4 and 5. Polar coordinates would also be an appropriate equivalent. For clarity, coordinates are not shown for virtual camera 215 which views from a different viewpoint and direction than camera 175 in the generated 3-dimensional world to simulate visual parallax.

[0063] Fig. 8 is a memory map of programs in RAM 90 in video game console 42 (Figures 1a and 3) and data processed by those programs. These programs and data are only examples and may be accompanied in RAM 90 by many other programs and data.

[0064] Fig. 9 illustrates a record format of exemplary data records for bi-directional communication between processor 50 in portable game system 47 and processor 86 in console 42 by way of cable 45 or wireless equivalent. Each data record 78 has several data fields including a portable control unit identification number so that console 42 will know which portable game system generated record 78 or to which portable unit the record 78 is being sent, a picture serial number specifying which sequence in the game is being referred to, and a size factor number specifying a degree of enlargement to relate LCD screen locations to simulated objects in the picture.

[0065] Each record 78 has an operation code which specifies the type of data and what type of processing is to be performed. Examples of operation codes include:

00 initial power up
01 identify location and size factor of displayed picture
02 move object located at $(X_1 Y_1)$ to location $(X_2 Y_2)$
03 first person approach to object located at $(X_1 Y_1)$
04 build object id3 between locations $(X_1 Y_1)$ and $(X_2 Y_2)$
05 change object located at $(X_1 Y_1)$ with object id3
06 destroy objects between $(X_1 Y_1)$ and $(X_2 Y_2)$
07 show hand grasping object at $(X_1 Y_1)$
08 show object at $(X_1 Y_1)$ entering object at $(X_2 Y_2)$
09 enlarge object located at $(X_1 Y_1)$
10 change camera angle to center on object at $(X_1 Y_1)$
11 retreat from object at $(X_1 Y_1)$
12 selection from action menu
13 cancel or undo previous action serial number nnn

[0066] Fig. 10 is a memory map of various programs and data in RAM 53 in portable game system 47 (Fig. 3). These programs and data are only examples and may be accompanied in RAM 53 by many other programs and data.

[0067] Fig. 11 illustrates the kinds of programs and data that are stored on optical disk 43 as tracks 82. These programs and data are only examples and may be accompanied on the disk or other data carrier by many other programs and data. Some of these programs may be executed in video game system 42, and some may be executed in portable game systems 44 and/or 47.

[0068] Programs from disk 43 that are executed in video game system 42 may perform the following functions, but are not limited to the following: load RAM 90 with other programs from disk 43, generate simulated 3D game worlds, generate 3D animated characters and other objects that move in the 3D world, generate game data to send to portable game system 47, processing game data received from portable game system 47, process input control data from a manual control device, detecting and determining effects of object collisions, detecting object entry into an given area of a simulated game world, detecting achievement of a goal, generating rewards, and keeping score.

[0069] Fig. 12 is a block diagram that illustrates two portable game systems 44 and 47 of similar design that are linked by data transmission link 45 which may be wireless. This linked system is also illustrated in Fig. 2.

[0070] In portable game system 47, a game program stored in RAM 53 is executed by processor 50 which may generate graphics commands that are processed by a graphics coprocessor (not shown) which generates animated picture data 146 from a variable viewpoint. This picture data 146 represents moving 3D objects in variable 3D views of a simulated 3D game world(s) that are rendered as 3D textured polygons in coprocessor process 301 in portable game systems 47 so that 3D characters and other objects in animated picture data 146 can be viewed from variable and rapidly changing 3D viewpoints and angles selected by players and/or selected by program instructions executed by processor 50. The moving 3D objects may be human-like characters having hands, arms, legs, faces, and clothing and performing actions in a simulated 3D game world.

[0071] The animated picture data 146 is stored in display RAM 302 (Fig. 6) and is converted by LCD drivers 119 to a dot matrix for display on LCD 22.

[0072] Processor 50 may process the following data in RAM 53: graphics data for a simulated 3D world, characters and other objects, definitions (polygons, textures, etc) of characters, objects, and terrain, joint articulation data, bumpmap data, 3D locations and orientation of objects, data defining movements of objects, and data for 2D maps, word menus, picture menus, and other data.

[0073] Execution of game programs in processor 50 is manually controlled by direction-switch 15 (only one of the 4 switches is shown), analog joystick 20, and/or other manual controls in system 47 and is affected by data received (arrow 154) by system 47 from processor 50a in system 44.

[0074] Processor 50 also executes instructions stored in boot ROM 76 and may also execute instructions stored in non-volatile external memory 16. Memory security processor 52 prevents execution of unauthorized instructions read from external memory 16.

[0075] Processor 50 receives (arrow 154) data records sent from portable game system 44 and this data affects execution of programs in processor 50 which sends data records (arrow 153) to portable game system 44 to affect execution of programs in processor 50a. Processor 50a generates data records 78 which it sends (arrow 154) to portable game system 47. An example of a data record 78 is discussed above with reference to Fig. 9. Other record formats may be transmitted between the two portable game systems 44 and 47.

[0076] Processor 50 also receives manually entered input signals from direction-switch 15, analog joystick 20, motion sensor, and/or other manual controls in portable game system 47. These input signals result from a human player's decisions based on animated pictures that are displayed on LCD 22 from animated picture data 146 generated by microprocessor 50 executing programs in RAM 53 and rendered by process 301 as textured polygons.

[0077] Likewise in portable game system 44, a game program stored in RAM 53a or external memory 16a or boot ROM 76a is executed by processor 50a which generates animated picture data 146a representing textured polygons rendered by process 301a for one or more 3D animated characters having hands, arms, legs, faces, and clothing and performing actions in a simulated 3D game world. This picture data 146a is converted by LCD drivers 119 to a dot matrix for display on LCD 22a.

[0078] Execution of game programs in processor 50a is manually controlled by direction-switch 15, analog joystick 20, motion sensor, and/or other manual controls in system 44 and is affected by data received (arrow 153) by system 44 from processor 50 in system 47.

[0079] In the preferred embodiment, one or both LCD 22 and LCD 22a display autostereoscopic images, so that each player may experience full depth perception of 3D characters and other objects and the 3D world viewed from different viewpoints on at least one of the two portable game systems 44 and 47. An example of an autostereoscopic LCD device is described below with reference to Fig. 13.

[0080] If external memory 16a is missing in portable game system 44, the game programs and data stored in external memory 16 may be transmitted from processor 50 in portable game system 47 to processor 50a and RAM 53a in portable game system 47 and executed in processor 50a.

[0081] One or both of the game systems 44 and 47 may read game programs and data from a data carrier such as an optically coded disk or mass storage device or Internet packets and may download such programs and data to a stereoscopic portable game system through data links that are preferably wireless. The stereoscopic portable game system may then be disconnected from other game units and operated as an independent stereoscopic portable game system.

[0082] Fig. 13 illustrates an exemplary cross-sectional view of an autostereoscopic LCD device 22 such as described above with reference to Fig. 12. The term "autostereoscopic" as used herein means providing parallax image information to both eyes, without requiring a viewing aid such as eyeglasses that provide image separation by polarization, anaglyphic separation by color, or separation by time division shutters. Further details of autostereoscopic LCD devices may be found in US patent application 2004/0012671.

[0083] The autostereoscopic LCD device 22 illustrated in Fig. 13 has an LCD display plane with alternating columns of pixels that provide interlaced image lines for the player's left eye and right eye. The LCD display plane is sandwiched between conventional input and output polarizers 340. A switchable parallax barrier 337 (a second LCD with transparent vertical slits) is also positioned, in this example, between the two polarizers 340. Backlight 341 provides transmitted illumination through the slits during 3D use.

[0084] Processor 50 sends an electrical signal (marked 3D in Figures 12 and 13) to parallax barrier 337 during 3D use which blocks transmitted light through the parallax barrier, and hence through the display plane LCD, except for the transparent vertical slits that provide illumination through each left-right pair of pixel columns in the display plane. If the 3D signal is not provided, parallax barrier 337 is transparent so that LCD screen 22 may display 2D images such as maps, words, numbers, symbols, graphs, cartoons, and 2D pictures.

[0085] Fig. 14 illustrates an exemplary cross-sectional view of an autostereoscopic LCD device 22 that has a backlight 341 and lenticular screen 342 to provide image separation without requiring a viewing aid. Further details of lenticular LCD devices may be found in US patent 6,055,013.

[0086] Fig. 14a illustrates an exemplary cross-sectional view of an autostereoscopic LCD device 22 that has a parallax barrier in front of the polarizer-LCD-polarizer sandwich to provide image separation without requiring a viewing aid. Further details of parallax barrier devices may be found in US patent 6,055,013.

[0087] The details of stereoscopic LCD device 22 are given here only as examples and numerous other designs may be used, and may include but are not limited to autostereoscopic displays, display devices that may or may not have a parallax barrier, display devices that may have a lenticular screen, dual display devices, and display devices that require additional polarizing filters or polarizing eyeglasses for a player's eyes.

[0088] The term "portable game system" is a term of art that means a handheld game system that is battery powered and contains a discrete display device (e.g. LCD) and can be operated as an independent game system without any connection to other systems or displays.

[0089] The details of video game system 42 and portable game systems 44 and 47 are given here only as examples and numerous other designs may be used.

[0090] The term "LCD" (liquid crystal display) has been used herein as an illustrative example of any display device having discrete dot-matrix picture elements. LED (light emitting diode) and plasma displays are also discrete display devices.

[0091] The term "program" as used herein may consist of more than one loadable module and typically includes executable instruction data, operation codes, digital addresses, and any other data that is typically part of a program module or modules.

[0092] Although I have described my invention with a degree of particularity in connection with what is presently considered to be the most practical and preferred embodiments, the foregoing description has been made only by way of illustration and example and is not to be interpreted as restrictive or limiting as to the meaning or scope of words in the patent or its claims. It is understood that various modifications, variations, arrangements, and/or equivalents, can be devised without departing from the spirit and scope of the invention defined by the claims.

[0093] Reference Numbers in Drawings

10	human game player
11	television (TV) set or video monitor
12	human game player
14	control switch
15	direction control switch
16	external memory
16a	external memory
17	player character
18	player character
19	linked system in general
20	joystick
21	joystick
22	LCD screen
22a	LCD screen
27	speaker
40	electrical connector
41	video signal cable to TV
42	video game system console
43	optical disk
44	portable game system
45	data link from console to portable game system
47	portable game system
50	processor in portable system
50a	processor in portable system
52	memory security processor
52a	memory security processor
53	RAM in portable system
53a	RAM in portable system
56	video screen
57	control switch
68	program process
69	program process
74	pixel data
75	pixel data

76	boot ROM in portable system
76a	boot ROM in portable system
78	data record
80	burst cutting area (BCA) of disk
82	tracks molded into disk
83	optical disk reader
84	security processor
86	cpu processor in console system
87	serial data connector
90	RAM in console system
119	LCD driver
146	animated picture data
146a	animated picture data
151	console program
152	portable game system program
153	data transmission
154	data transmission
173	virtual camera
175	virtual camera
177	"camera" angle
185	conventional handheld controller
186	data link to auxiliary display
187	table or other physical support
215	virtual "camera"
216	"camera" angle
301	polygon rendering
301a	polygon rendering
337	parallax barrier
338	interlaced stereoscopic pixel data
340	polarizer
341	backlight
342	lenticular optical screen
343	transparent slits in parallax barrier